Flavor Profile Analysis (FPA) and the Taste & Odor Wheel (TOW)

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Can we rely only to untrained consumers?

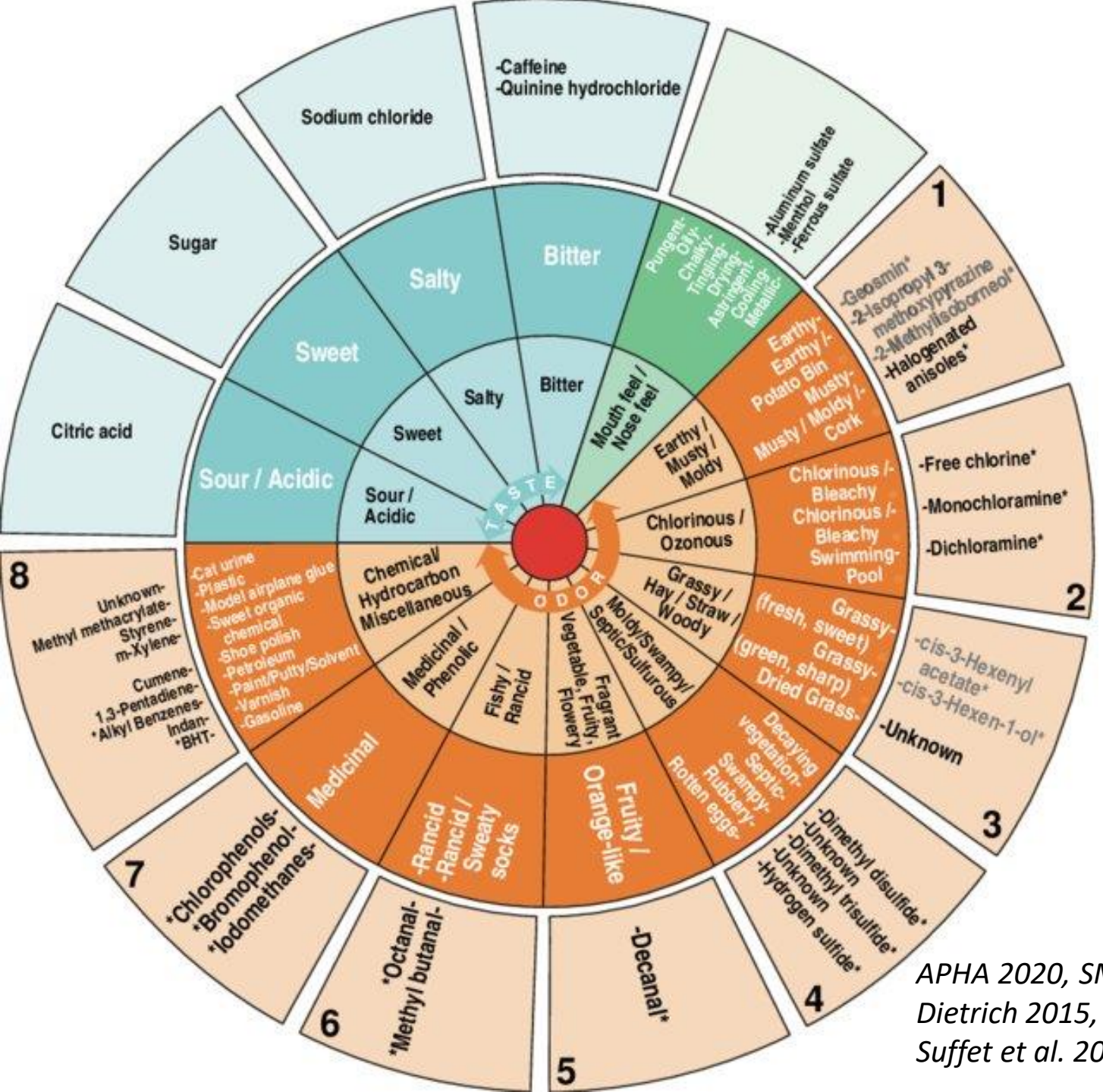
- Large variation in perception of T&O.
- No common language and descriptors to verbally describe T&O.
- Odor thresholds may vary by more than 2 orders of magnitude between individuals.
- Physical condition of individuals.
- Ranging from hypersensitive to anosmic.
- Phycological factors & biases.
- Motivation, dedication to testing.
- Women generally better in detecting/characterizing T&O.
- Reliability of data produced by consumers.

Flavor Profile Analysis

APHA SMWW method 2170

- Intensive training and standardization of panelists (usually 4-7 panelists).
- Determines odor descriptors.
- Determines intensities on a 7-point scale: threshold (1), slight (2), weak (4), medium (6), medium strong (8), strong (10), and very strong (12).
- Training with standard compounds at specified concentrations.
- Tests are usually performed at 45^{o}C or 25^{o}C.
- Initially panelists make an individual assessment.
- Results are then discussed, and the panel reaches a consensus.
- Quality control: Odor-free samples & duplicates.
- Can be applied to determine OTCs.

Water TOW



- Taste
- Odor
- Mouthfeel/nosefeel

- Inner wheel: Main categories.
- Outer wheels: Specific descriptors & compounds.

- Note some “unknowns”.

- Discuss the origin of compounds.

APHA 2020, SMWW, method 2170 (FPA)
Dietrich 2015, Web Report #4537
Suffet et al. 2019, Chapter 2 in T&O in Source & Drinking Water, IWA

Variability of odor descriptors

a. Odor of 2-Methylisoborneol

b. Odor of d-Limonene

c. Odor of n-Heptanal

d. Odor of Toluene

Dietrich & Burlingame, 2022, STOTEN, https://doi.org/10.1016/j.scitotenv.2019.135061

Taste and Odor descriptors

Table 2
Overall sensory characteristics based on review and interpretation of the literature.

ID	Tastant/Odorant	Strength of a Consensus	Taste and Odor Descriptors		
			Dominant Descriptors (this work)	Minor Descriptors (this work)	Standard Method 2170 T&O Wheel
1	Geosmin	Moderate	Earthy/Musty	Muddy, Dirt, Moldy	Earthy
2	2-Methylisoborneol	Moderate	Earthy/Musty	Moldy	Musty
3	2,4,6-Trichloroanisole	Moderate	Musty/Moldy	Earthy, fruit, rotten fruit, chlorinous	Musty/Moldy/Cork
4	2,4,6-Tribromoanisole	Moderate	Musty	Rubber, moldy, earthy	Musty/Moldy/Cork
5	d-Limonene	Moderate	Citrus	Orange, lemon	NA[1]
6	n-Heptanal	None	–	Oily, fatty, chemical, musty/earthy/moldy, rancid, sweaty, grass, sickening, and stale	NA
7	Nonanal	Moderate	Orange	Cucumber, rose, waxy	NA
8	2-Nonenal	Weak	Fatty, green, cardboard	Citrus, waxy, fishy, pungent, cucumber, musty	NA
9	Free Chlorine	Strong	Chlorinous	Bleachy	Chlorinous, bleachy
10	Monochloramine	Strong	Chlorinous	–	Chlorinous, bleachy
11	Dichloramine	Strong	Swimming pool	Chlorinous	Swimming pool
12	Naphthalene	Strong	Moth Ball	Tar, aromatic	NA
13	Toluene	Weak	Chemical	Solvent, gasoline, paint, cleaning fluid	Paint/Putty/Solvent[2]
14	1,2,4-Trimethylbenzene	Strong	Shoe Polish	Coal tar	Paint/Putty/Solvent[2]
15	Methyl-t-butyl ether	Strong	Sweet solvent	–	Sweet solvent
16	Ethyl-t-butyl ether	Moderate	Chemical solvent	Sweet, bitter, burning	NA
17	Hydrogen sulfide	Strong	Rotten egg	Sewage	Rotten eggs
18	Ethylene glycol)	Strong	Sweet taste	Syrupy	NA
19	Sodium (as NaCl)	Strong	Salty taste	–	Salty
20	Copper (II)- flavor	Moderate	Metallic odor	Penny-like, astringent, blood-like	NA
		Strong	Bitter taste	Salty	NA
21	Iron (II) - flavor	Moderate	Metallic odor	Blood-like, penny-like,	NA
		Strong	Bitter taste	Salty	Metallic

NA- not applicable as T&O wheel does not contain this chemical.
The T&O Wheel described alkybenzenes, which include toluene and 1,2,4-trimethylbenzene, as "Paint/Putty/Solvent".

Dietrich & Burlingame, 2022, STOTEN, https://doi.org/10.1016/j.scitotenv.2019.135061

Factors to consider in water T&O testing

TABLE 1 Psychological, context, and human sensory capability factors to consider in taste and odor testing

Factors	Selecting Assessors	Designing the Test	Administering the Test	Analyzing and Interpreting Data
Language	X	X	X	X
Gender, age, smoking habits	X	X		X
General health	X			X
Prior exposure to tastants/odorants	X			X
Specific anosmia	X			X
Prior experiences and training	X	X	X	X
Willingness to participate	X		X	X
Taste exposure technique		X	X	X
Odor exposure technique		X	X	X
Sensitization	X			X
Fatigue		X		X
Expectation error		X	X	X
Error of habituation				X
Stimulus error		X		X
Logical error		X		X
Halo effect		X		X
Contrast effect		X		X
Group effect		X		X
Error of central tendency		X		X
Pattern effect		X		X

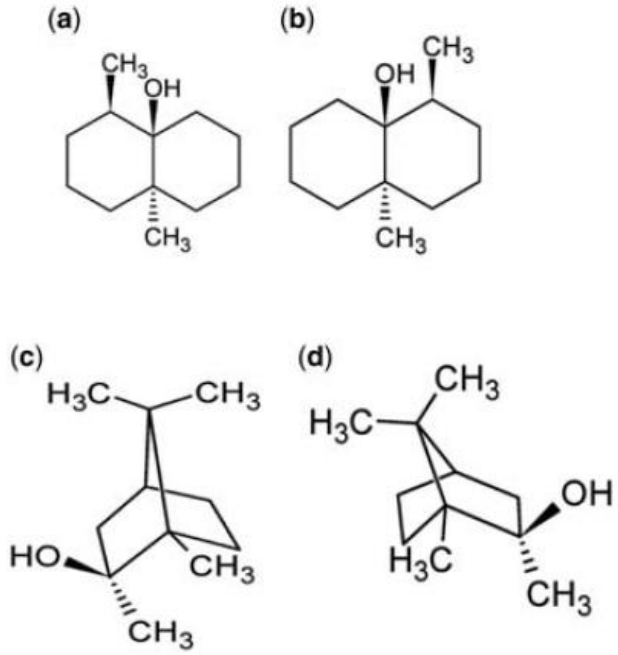
Burlingame et al. 2017, Journal AWWA, https://doi.org/10.5942/jawwa.2017.109.0118

Stereochemistry and OTC

Natural (-) geosmin has a lower OTC.

Table 2.3 Odour threshold concentration (OTC) for geosmin as a function of isomer and temperature.

Geosmin Optical Isomer	Temperature (°C)	OTC (ng/L)	References
(±)	45	0.8	Piriou *et al.* (2009)
(−)	45	0.6	Piriou *et al.* (2009)
Not reported	45	3.5	Mackey *et al.* (2008)
(±)	40	3.8	Young *et al.* (1996)
(+)	45	6.7	Piriou *et al.* (2009)
(−)	17–19	9.5 ± 1.3	Polak and Provasi (1992)
(−)	25	10	Sagiura *et al.* (1983)
(−)	Not reported	15	Persson (1979a)
(+)	17–19	78 ± 12	Polak and Provasi (1992)



(+) (a,c) and (-) (b,d) optical isomers of geosmin and MIB

Suffet et al. 2019. Chapter 2 in "T&O in Source & Drinking Water: Causes, Control & Consequences, , IWA

Let's test some samples !

1. Sniff some samples with characteristic water T&O. **Do not drink !**

   Can you sense the odor?

   Can you characterize the odor using the TOW?

   Choose a descriptor for each sample, using the on-line app.

2. Triangle test: You will be introduced to 3 samples of water. You can sniff and taste the samples.

   Can you tell which of the three samples is different from the other two?

   Use your noseclip to shut-down and re-open the retronasal pathway.

   Can you spot differences now?

Use the weblink or QR code to submit results via your mobile phone or laptop.

Discuss the results.

Have fun !